Temperature Imaging using Quadriwave Shearing Interferometry. Applications in Thermoplasmonics

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The use of illuminated gold nanoparticles as ideal nanosources of heat is the basis of numerous research activities and applications in physics, chemistry, biology and medicine. This field defines the area recently named Thermoplasmonics [1]. In most of the activities related to Thermoplasmonics, probing the temperature at the vicinity of the metal nanoparticles is not an easy task.

In this context, we recently developed a novel optical microscopy technique, named TIQSI, aimed at mapping the temperature around plasmonic nanoparticles [2]. The approach is based on the measure of the thermal-induced variation of the refractive index surrounding the sources of heat. The TIQSI technique cumulates all the advantages a thermal microscopy technique may require: i) high resolution (diffraction limited), ii) high readout rate (less than one image per second), iii) high temperature sensitivity (<1°C), iv) large accessible temperature range, v) temperature can be measured without fluorescence labelling or any other kind of thermal probe, v) no need to use sophisticated devices such as heterodyne detection, acousto-optic modulator, spectrometer, etc, like previous thermal imaging techniques.

In this presentation, we will first introduce the TIQSI technique, its principle and capabilities. We will then present several recent applications made it possible by this new thermal imaging technique. In particular, we shall explain how this technique have been already used to quantitatively measure the absorption cross section of gold nanoparticles [3] and graphene sheets, how it can be used to map the temperature in real time in living cells [4], how it can help to design temperature distributions at will at the microscale using gold nanoparticles [5,7], and how it can be used to investigate thermal-induced phenomena in hydro-dynamics and phase transitions [6].

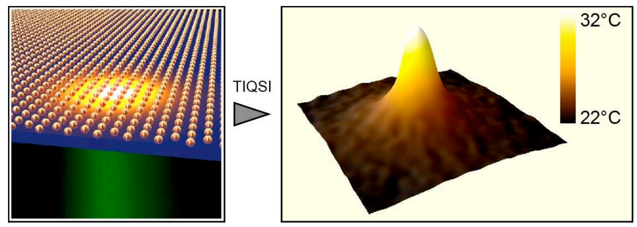

Fig. 1: (left) 3D view of the experimental configuration: a gold nanoparticle layer illuminated and heated by a laser light. (right) The associated measured temperature distribution.

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